6 THE PERIODIC TABLE

Reviewing Content

24. so that known elements with similar properties could be put in the same group

25. The close match between the predicted and actual properties of gallium helped gain wider acceptance for Mendeleev's periodic table.

26. a periodic repetition of their physical and chemical properties

27. Yes, both carbon and silicon are in Group 4A, and each has four (valence) electrons.

28. **a.** nonmetal **b.** nonmetal
c. metal **d.** nonmetal
e. metal

29. Metalloids have properties that are similar to those of metals and nonmetals. How a metalloid behaves depends on the conditions.

30. Group 1A, Group 2A, Group 7A, and Group 8A, respectively

31. Na, Mg, Cl

32. helium

33. **a.** aluminum

34. **a.** $1s^2 2s^2 2p^1$
b. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^2$
c. $1s^2 2s^2 2p^5$
d. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$
e. $1s^2 2s^2 2p^6 3s^2 2p^1$

35. **a.** Ar, $1s^2 2s^2 2p^6 3s^2 3p^6$
b. Si, $1s^2 2s^2 2p^6 3s^2 3p^2$
c. Mg, $1s^2 2s^2 2p^6 3s^2$

36. **a.** sodium **b.** strontium
c. germanium **d.** selenium

37. The first ionization energy is the energy needed to remove a first electron from an atom. The second ionization energy is the energy needed to remove a second electron.

38. **a.** boron **b.** magnesium
c. aluminum

39. **a.** Sr, Mg, Be **b.** Cs, Ba, Bi
c. Na, Al, S

40. It is relatively easy to remove the first electron from an alkali metal atom; it is much more difficult to remove the second.

41. The ionic radius of a cation is smaller than the atomic radius of the metal atom.

42. **a.** Na **b.** S^{2+}
c. I^- **d.** Al

43. **a.** F **b.** N
c. Mg **d.** As

44. Noble gases, with rare exception, do not form compounds.

45. **a.** O **b.** F
c. O **d.** S

46. a and c

Understanding Concepts

47. **a.** 1851–1900
b. Mendeleev's periodic table helped scientists predict the existence of undiscovered elements.
c. 75%

48. **a.** C **b.** La
c. B, Ne, P, Br **d.** Sb, Bi

49. b; Nitrogen and phosphorus are in the same group (group 5A).

50. Fluorine has a smaller atomic radius than oxygen because fluorine has a larger nuclear charge. Fluorine has a smaller radius than chlorine because it has eight fewer electrons.

51. nonmetals; The trend is for ionization energy to increase from left to right across a period.

52. **a.** Ca^{2+} **b.** P^{3-}
c. Cu^+

53. **a.** H, Li, Na, K, Rb, Cs, Fr
b. O, S, Se, Te, Po **c.** Zn, Cd, Hg, Uub

54. An element's electron configuration determines its location (group) in the periodic table.

55. c

56. 170 pm

57. First ionization energy increases across a period.

58. It is relatively easy to remove two electrons from magnesium; it is much more difficult to remove a third electron. It is relatively easy to remove three electrons from aluminum; it is much more difficult to remove a fourth.

59. **a.** The atomic radius increases from top to bottom within the group.
b. Cations are smaller than their corresponıding atoms. The attraction between the nucleus and any remaining electron is greater. There is one fewer occupied energy level.

Critical Thinking

60. Yes, 113; 1 through 112 are known.

61. **a.** Electronegativity increases as first ionization energy increases.
b. Both properties depend on the attraction between the nucleus and electrons in the highest occupied energy level. The nuclear charge increases, but the shielding effect is constant.

62. Zinc has a greater nuclear charge (more protons) than calcium.

63. **a.** The electrons in calcium are removed from the same energy level. In potassium, the second electron is removed from an energy level closer to the nucleus.
b. Because cesium has a larger atomic radius than lithium, the nuclear charge in a cesium atom has a smaller effect on the electrons in the highest occupied energy level.
c. It is relatively easy to remove all three electrons from an aluminum atom, but the third electron removed from a magnesium atom is in an energy level closer to the nucleus.

Concept Challenge

64. Mg^{2+} has more protons in its nucleus; its attraction for electrons is greater.

65. The ionic radii would decrease from S^{2-} to Sc^{3+}. The number of electrons and the shielding effect do not change, but the number of protons increases from left to right in this series. So the ionic size decreases. The same is true for the series O^{2-} to Mg^{2}.

66. There is not a 1:1 correspondence. Explanations will vary.

67. **b.** The largest increase is between ionization numbers 4 and 5 because carbon easily loses the first four electrons from the second energy level. The fifth electron is removed from the first energy level.

68. **a.** Possible cations are Rb^{+} and Sr^{2+}; possible anions are Br^{-}, Se^{2-}, and As^{3-}.
b. No; a cation is isoelectronic with the noble gas in the preceding period, and an anion is isoelectronic with the noble gas in the same period.

69. **a.** Electron affinity should increase from left to right across a period because the nuclear charge increases and the shielding effect is constant.
b. Electron affinity should decrease from top to bottom within a group because the number of occupied energy levels and the shielding effect increase.

Cumulative Review

70. Answers will vary but should mention scientific method, observations, experimentation, and hypotheses.

71. **a.** physical change
b. chemical change
c. physical change
d. chemical change

72. Use a magnet; iron beads are attracted to magnet, copper beads are not. Use tweezers and a magnifying glass; iron beads are silvery black, copper beads are dull red.

73. 4

74. **a.** 3
b. 8, the hundredths place

75. The density of the cube is 0.984 g/cm^3. The cube will float.

76. **a.** 2.24×10^{-9} m
b. 8.13×10^{-2} m
c. 7.4×10^{-12} m
d. 9.37×10^{-3} m

77. 5.2%

78. 5.2×10^3 g

79. The density of the olive is 1.05 g/cm^3. The olive will sink.

80. 173

81. The slope and the density should be about 2.1 g/cm^3.

82. 2.57×10^2 mL

83. 4.54 g/cm^3

84. **a.** 48
b. 44
c. 114
d. 110

85. **a.** silver, 62 neutrons
b. tin, 50 protons
c. molybdenum, 42 electrons
d. scandium, 21 electrons

86. **a.** none
b. one, 2*p*
c. none
d. none